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SCHOOL PLANT STUDIES

SCHOOL LIGHTING
20 YEAR PROGRESS REPORT

by CHARLES DANA GIBSON

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- DAYLIGHTING
- NEW POSSIBILITIES IN DESIGN
- FALSE EMPHASIS ON QUANTITY
- VISUAL COMFORT & EFFICIENCY
- GETTING TOGETHER
- LIGHTING GOALS
- CONCLUSIONS
- FRAME-OF-REFERENCE

THIS IS FOURTEENTH OF A SERIES OF PAPERS PREPARED BY MEMBERS OF THE AIA COMMITTEE ON SCHOOL BUILDINGS, & BY SELECTED SPECIALISTS, TO MAKE LAYMEN AWARE OF SCHOOL BUILDING PROBLEMS & TRENDS & TO STIMULATE DISCUSSION. THEY ARE NOT INTENDED TO BE DEFINITIVE LAST WORDS & CARRY ONLY THE AUTHORITY OF THEIR RESPECTIVE AUTHORS. THE SERIES WILL BE EDITED BY THE COMMITTEE & ISSUED BY THE AIA DEPARTMENT OF EDUCATION & RESEARCH UNDER SPONSORSHIP OF THE AMERICAN ARCHITECTURAL FOUNDATION. MANY NEW SUBJECTS ARE BEING WORKED ON & CONTRIBUTED ARTICLES ARE WELCOME. WIDE-SPREAD DISTRIBUTION TO LAYMEN & EDUCATORS IS MADE OF THESE NON-TECHNICAL ARTICLES IN REPRINT FORM.

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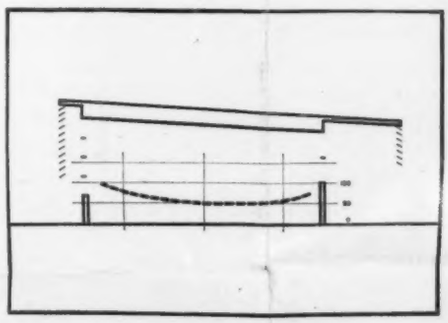

bilateral lighting with sun control

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SCHOOL LIGHTING—20 YEAR PROGRESS REPORT

by Charles Dana Gibson *

Let us begin our review of school lighting history with installation of bare lamps in classrooms. Some places I know never got past that initial stage. Some have been past it & are now back to it. Whole story at first was getting "some" electric light into schoolrooms. Emphasis was on raising lighting levels to 10-15 footcandles.

As that trend continued, electric lighting installations were evaluated in terms of amount of light they produced at desk-level.

"Quality lighting" for most part then was a laboratory term. Theorists kept on writing about it & industry kept right on selling footcandles. Finally, however, a good indirect incandescent lighting system became more & more respectable until, with few exceptions, electrical industry was including concept of quality along with quantity.

Then came fluorescent! From the gaudy midway of a World's Fair this infant son of Gaseous-out-of-Discharge made his diaper-clad appearance. There have been few occasions indeed when any segment of industry has staged such an intensive propaganda campaign for a product. Fluorescent became "the modern light source" & commonly exchanged fixture for fixture when relighting "old" incandescent jobs. Practically overnight hot & cold running cathodes & magical phosphors were creating & transforming ultraviolet energy into the Light of the World.

What happened to the "quality" school lighting story the literature had loudly proclaimed? The quality story was forgotten. From same pens & same pages the quantity story took over again. We had made full circle & were back singing "Bring-out-doors-indoors." Lessons & progress of preceding years were traded-even for a light source which by nature of its poor application broke nearly all established rules for quality lighting.

Fortunately for cause of good school lighting, World War II put an end to this mad rush. Its result was the critical materials tie-up, plus continued research on & refinement of fluorescent sources during war years. Remainder of last 10-yr period has witnessed continuing trend toward quality-with-fluorescent until again respectable school lighting solutions include element of quality with both incandescent & fluorescent sources.

* see p 128

daylighting:

Now let's review briefly history of daylighting. Since it was the original, & in many cases only school lighting source, daylight has been classified by most people as the prime source for school lighting. Electric lighting has been classified as a "supplemental" light source. However, currently this concept is being challenged in some situations.

At first any daylighting technique went unchallenged. Sun exposures with unshielded glass were common for classrooms. Old fallacy of "flushing the room with sunlight" created intolerable visual conditions for 1000s of pupils & teachers. Out of that primitive era we emerged into a controlled orientation approach to school-housing design. Since north-light offered best around-clock-daytime light source with fewest glare-control problems, the now internationally famous "finger-plan" for school plants developed. Dr Charles Bursch,* the Paul Bunyan of school planning progress, created this finger-plan approach. He thus began a series of developments which already have caused international re-appraisal of school plant design techniques & which will continue, by constant refinement, to increase educational usefulness of school buildings.

new possibilities in design:

Again World War II made significant contribution to school design — this time in construction materials & techniques. Development of laminated wood & light steel structural members during that crisis made possible economical construction of wide-span structures. Freeing of school design from shackles of 24' classroom spans & introduction of relatively inexpensive structural materials & construction techniques in form of rigid-frame design, opened new architectural vistas. Bi-lateral & tri-lateral daylighting design became common. With multi-source daylighting came sun-control problems which eventually developed into concern for sky-brightness controls. (see diagrams)

false emphasis on quantity:

Twenty years ago we talked with naive ignorance about importance of school lighting. Fallacious emphasis on quantity led people to believe that more light we had the better we could see & learn. Literature reeked with reports of so-called research which proved that pupils learned more in rooms with X footcandles than they did in classrooms with -X footcandles. (And even recently one lamp manufacturer issued a leaflet addressed to school administrators recommending that they make an easy check of their schools with a light-meter to see if they needed relighting!)

This misguided emphasis shows ignorance of the learning process. If time permitted we could review at length reasons given by electrical industry for wanting to provide schools with more electric lighting equipment & more electrical power.

visual comfort & efficiency:

Today we talk in terms of brightness-balance & conservation of human resources. De-emphasis on quantity has not discarded footcandle as major lighting measurement unit, it merely has placed it in its proper relationship to other lighting factors. We do say, however, that after we have produced 20 footcandles at task level, other quality factors making for reasonable brightness-balance take over.

We make no claims that poorly lighted schoolrooms "ruin the eyes" or produce ignorant pupils. We do say, however, that any school design which does not provide the best we know for visual comfort & efficiency is costing pupils & teachers unwarranted amounts of physical energy.

To perform critical seeing tasks in a properly conditioned visual environment requires expenditures of large amounts of our energy resources. As any environment becomes less & less adequate in terms of visual comfort & efficiency, en-

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ergy cost for critical seeing becomes greater & greater. This fact has physical, emotional & educational growth & development implications for pupils which are far more important to school administrators, teachers, pupils, parents & electrical industry than any bread-&-butter arguments for good school lighting advanced in past.

getting together:

Most significant activity of people now interested in school lighting design is constructive communication. By this I mean that groups with varying interests in the same field get together & rationally present their point-of-view & then, with a cooperative mind-set, listen to other fellow's point-of-view.

In October 1952, the writer, acting as liaison officer from the National Council on Schoolhouse Construction, had a half-day conference in New York City with C. L. Crouch, Technical Director of the Illuminating Engineering Society. Points of difference were put on the table & need for better cooperative effort by both organizations was agreed upon.

In December 1952, entirely independently, the American Institute of Architects requested that IES hold a joint committee meeting with them to discuss possible revision of the document "American Standard Practice for School Lighting (1948)." Because of current heavy agenda this meeting was not held until October 1953 (Nela Park, Cleveland, Ohio), at which time the AIA suggested that NCSHC be invited to work with IES & AIA in event it was decided to revise the document.

In meantime entire June 1953 issue of "Illuminating Engineering" was devoted to school lighting with members of NCSHC contributing major articles. Official liaison reports to NCSHC for 1952 & 1953 included materials prepared by Mr. Crouch which reviewed activities of IES committees in field of school lighting or related areas.

(Committees from the 3 national groups mentioned have now held 2 more meetings & revision of the obsolete standard document has begun.)

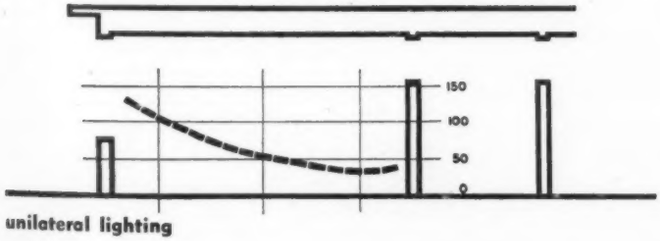
Fact that official IES publications on recommended practice continue to disagree on points of common concern is best evidence of confusion within electrical industry. There is, however, a desire for constructive communication & IES is making sincere efforts to clear up controversial points by research. Independent studies conducted in major universities are now beginning to provide much more stable basis for effective lighting design than we have had in past. Last year another major group within electrical industry began a research program. Pacific Coast Electrical Association has appointed a school lighting committee to set up & supervise a program — half of which is underway:

■ project no 1: establishment of a "Service to Industry" contract with University of California at Berkeley for library research & evaluation:

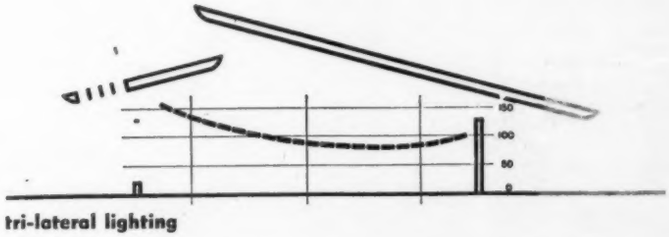
- **review school lighting literature to determine kinds & amounts of past research in field of school lighting**
- **evaluate probable validity**
- **determine areas already adequately investigated**
- **outline areas needing research before reliable data will be available**

The university has accepted this contract with understanding that results would be made available to schools thru California State Department of Education & that university has right to publish any findings with or without sanction of PCEA.

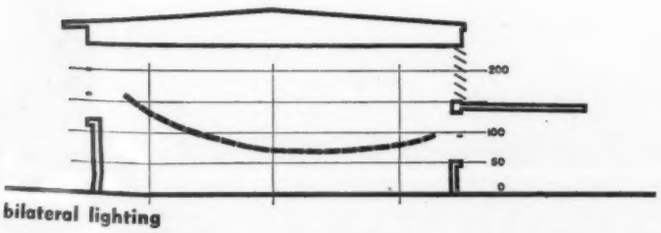
■ project no 2: study of brightness conditions in schools & rating them in terms of visual comfort. PCEA committee is exploring possibilities



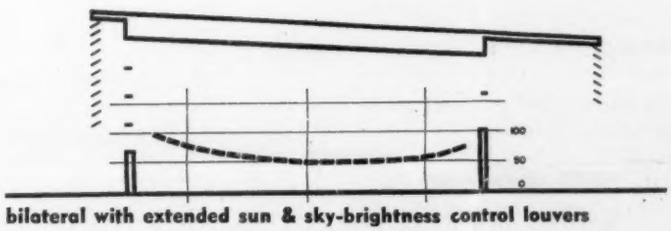
unilateral lighting



tri-lateral lighting



bilateral lighting



bilateral with extended sun & sky-brightness control louvers

all cuts from Texas Engineering Experiment Station booklet: "geometry of classrooms . . . " (Caudill & Reed 1952)

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SCHOOL LIGHTING (concluded)

GIBSON

of this project in terms of the new direct-reading brightness meter & intends to provide latest lighting recorders & other instruments to facilitate work. Committee is now supervising 24-hr/day light & brightness recording experiment in actual classroom situation.

Big job for project 2, however, is setting up format for brightness study. Before main project is defined in detail, best advice available in fields of ophthalmology & general medicine will be obtained. Actual brightness research will be conducted by UCLA & we hope can be tied in with IES studies.

lighting goals:

Objectives established by NCSHC are listed because they reflect frame-of-reference, they are realistic in terms of visual comfort & efficiency & follow closely general recommendations of Quality & Quantity Committee of IES:

- footlambert brightness of any surface viewed from any normal standing or sitting position in schoolroom should not exceed 10X footlambert brightness of poorest-lighted task in room.
- footlambert brightness of any surface viewed from any normal standing or sitting position in schoolroom should not be less than 1/3 footlambert brightness of poorest-lighted task in room
- footlambert brightness of any surface immediately adjacent to task should not exceed 3X task brightness.
- brightness difference between adjacent surfaces should be reduced to minimum.
- brightness goals stated above assume lighting system that provides from 20-40 footcandles on poorest-lighted task. As footcandle levels are increased, sources of high brightnesses should be controlled to more nearly approach brightness of task.

Extent of area of surface producing brightness has measurable effect upon visual comfort. Small areas of either extremes of brightness generally are less noticeable than large areas of same brightness.

Term "task," as used in above definitions of goals, is interpreted to include any visual task which may be encountered in a schoolroom:

book on desk
symbols on chalkboard
(perhaps most difficult)
lab apparatus
artwork on easel
exhibits on tackboard
motion pictures
lantern slides

On basis of this concept it is apparent that tasks may be in either horizontal or vertical plane & may require student to face in any direction. Visual tasks in schoolrooms range in brightness-differences from reading black symbols on white paper to sewing with black thread on black cloth. Other factors remaining constant, visual comfort & efficiency increase with increase in brightness-difference within task.

conclusions:

- **daylight & electric light will be considered a complementary team of energy sources working toward same goals. Instead of being designed as separate problems, they will be coordinated in basic design pattern. Adequate controls for all daylight & electric light sources will be considered a prime part of design problem & not as appendages, alternates or afterthoughts**
- **lighting systems that meet brightness-balance goals advanced in this paper will be considered an integral part of school building. They will not be considered expendable in order to provide funds for less necessary educational & architectural features**
- **further design experimentation will continue but will be based on defensible & objective goals to be accomplished rather than on impelling urge to be different or use of propagandized equipment, materials or techniques**
- **we will begin our design thinking in terms of our best results to date & then, by using progress we already have made, we will further refine known good solutions to take them farther toward planned & accepted goals.**

FRAME-OF-REFERENCE:

- **brightness-balance instead of high footcandle levels is prime consideration in establishing acceptable visual environment for critical seeing tasks**
- **visual comfort & efficiency depends upon establishing & maintaining max & min brightness-differences between task & areas of high brightness & between task & areas of low brightness in 360° visual field**
- **no inhibitions should be placed upon seating or other work-station arrangements within room in effort to establish visual comfort**
- **high levels of illumination without brightness control do not mean better visual environment**
- **sky brightness & ground brightness are 2 major daylight sources & both must be controlled in order to produce positive visual environment for critical seeing tasks**
- **use of ground brightness as an effective daylight source can be part of planned design of building**
- **function of electric lighting is to supplement or replace daylighting**
- **both general light sources should be subjected to same brightness limitations & design of both sources should be coordinated to provide acceptable performance from both in completed structure**
- **maintenance problems created by lighting design must be held to minimum**
- **progress in daylight design depends not only upon development of more effective classroom sections but also upon planned & intelligent integration of all buildings in a school plant into patterns which guarantee daylight sources as well as sky brightness control**
- **orientation of buildings alone will not solve problems of brightness-balancing**
- **building design develops from correlation of interior & exterior elements which, in combination, produce comfortable & efficient visual environment**

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